NASA JOHNSON SPACE CENTER SPACE SHUTTLE PROGRAM
TACIT KNOWLEDGE CAPTURE PROJECT
ORAL HISTORY TRANSCRIPT

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INTERVIEWED BY REBECCA WRIGHT
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WRIGHT: Today is April 14th, 2008. We are at the NASA Johnson Space Center to speak with Wayne Hale, NASA's Deputy Associate Administrator for Strategic Partnerships. This interview is being conducted for the JSC Tacit Knowledge Capture Project for the Space Shuttle Program. Interviewer is Rebecca Wright, assisted by Jennifer Ross-Nazzal. We want to thank you for taking time out of your very busy schedule to meet with us today. You spent the past three decades with the space agency. Tell us how you first came to work with the Space Shuttle Program and then how these duties evolved.

HALE: I had known in college that I wanted to work in the space program. When I got my bachelor's degree completed was at the low ebb of employment, post-Apollo. So I went to graduate school, and while I was in graduate school a NASA recruiter came to Purdue University [West Lafayette, Indiana] where I was when I was interviewing for jobs toward the end of that. I applied and told him I was interested in working at Johnson Space Center rather than Lewis Research Center, now Glenn Research Center [Cleveland, Ohio]. So they forwarded my application down here, and it caught the eye of the folks in Mission Operations, Flight Operations they called it in those days. They were very interested in getting some new young people to start to staff up for the [Space] Shuttle. So in the spring of 1978 I was given a job offer, came to work in June of 1978, but with the prospect of the first Shuttle flight being in

March of 1979, and of course that wound up being April of 1981 as these things turn out, but that did give me an opportunity to come in during the final design, and certainly the time that we were doing the initial operations, training and planning for the first big Shuttle flights. I was very pleased to get a job opportunity in Mission Control.

WRIGHT: What were some of the first duties? We know that you went to work for the propulsion systems.

HALE: They assigned me to the propulsion systems, which is orbital maneuvering system, reaction control system. We had a number of procedures to write, crew procedures. The systems had been designed, but none of the operations procedures had been finalized. So we worked on crew checklists. We worked on flight rules. We worked on all the operational procedures, the console procedures that are used in Mission Control for planning and executing missions regarding those systems. Malfunction procedures, troubleshooting procedures, and all of those sorts of things. Those were the first assignments. A lot of going to training classes and then into either the single systems trainers, and then later into the integrated simulations in Mission Control.

WRIGHT: Ten years after you got here, you changed jobs in the sense that you went to the Flight Director Office. Tell us how that transition happened and the work that you did there.

HALE: Well, it was fairly standard procedure for new flight directors to be chosen from the ranks of first-line supervisors in the flight control organizations. I had been not only a propulsion

system officer. I had gotten a job as a first-line supervisor in the integrated communication section, INCO. They later moved me back to the propulsion systems because of some personnel moves. They were precipitated by other folks leaving. So I had served as the leader there and had always had as a goal in my career to become a flight director, the epitome of Mission Control, the top rung in the organization, and was interviewed and was pleased to be selected on Sadie Hawkins Day, February 29th, 1988. We were notified, three of us, that we had been selected to be that year's class of flight director candidates.

Immediately we began the process of transferring our old jobs to our designated person who was going to act in our old position until they could formally select, and then into the Flight Director Office, which began a whole new career in education. Prior to that time of course I had been a specialist in my subsystems. You knew general things about the Space Shuttle, and you knew how your particular area of expertise fit in. But there was a lot that I didn't know. A flight director has to know an awful lot about every aspect of the Space Shuttle. So we spent quite a bit of time training.

That was in the time of course between the loss of the Space Shuttle *Challenger* [STS 51-L] and the Return to Flight in September [29, 1988, STS-26, Space Shuttle *Discovery*]. So we had a fair amount of time to go through training, the three of us—Bob [Robert E.] Castle, [Jr.,] Rob [Robert M.] Kelso, and myself were selected in that class—and get quite a bit of time to observe the senior flight directors as they went about their duties and then started taking integrated training ourselves as flight directors.

So one of the tasks that was assigned to a new flight director is to run what we called flight techniques panel. Flight techniques, which I guess grew out of MPAD's [Mission Planning and Analysis Division] mission techniques for Gemini and Apollo, had become a flight director

office responsibility. I was assigned to run flight techniques where we talked about all kinds of issues, operational issues, systems problems, constraints, manifesting issues. We were supposed to resolve these in an operational level, make a recommendation back to the Space Shuttle Program as a position. So we had to be very in-depth in a technical sense, be very broad to look at all the disciplines that were involved in the operation of a flight, and in fact understand the engineering behind the various ground and flight systems that we're involved. That's quite a good training ground, because you get a lot of interaction with many of the different disciplines, engineering and safety and the science community, payloads community and customers, and on and on and on. It's a really good training ground. After you go through that you find out what you don't know, and that helps you to go study some more and ask questions and become more well-rounded.

Once you get in Mission Control as a flight director, you don't have time to do the research. You have to already know it because decisions are required in very rapid order. Like so much of NASA's business, you don't have time to have a committee discussion a lot of times, and you're weighing off the best of a number of possible options with some unknown residual of risk, some unknown residual of how much do we really know about the situation. You will never know as much as you would like to know about a situation. You just have to gather as much information as you can, and when the clock counts down to the critical time that you have got to decide, then the flight director decides. Sometimes with upper level management help. Particularly on those issues that have got a longer time span on the order of days. But frequently on your own.

WRIGHT: At some point you decided to move to Florida for a short period of time.

HALE: I had a rather long career as a flight director. I was in the Flight Director's Office for 15 years, in round numbers, from February 29, 1988 until February 1, 2003. So that's 14 years and 11 months. During that time I'd been frequently counseled that I should think about moving into a senior management position, or at least trying out a senior management position.

The way that came about, NASA Headquarters [Washington, D.C.] had a rotational assignment that came open. The Associate Administrator for Shuttle came open. Parker Counts had been doing that job. He retired. They wanted to have a one-year rotation, and after having been strongly urged to consider options like that, this one appealed to me. I wouldn't have to move the family. It was a one-year temporary duty assignment, and it would give me insight to NASA Headquarters, which everyone had always counseled me to be good for your career, to understand a little bit about how NASA Headquarters works and the kinds of things that go on there. In fact, I think it would have been a very good assignment.

However, Ron [Ronald D.] Dittemore, who was Shuttle Program Manager—had been a flight director, had been a propulsion systems officer—somebody that I'd known for 20 years at that point, called me to his office and said, "We found out you were applying for this job. I have another job that I'd like you to consider in place of that," which was the Manager for Launch Integration for the Space Shuttle Program.

Of course we worked very closely in Flight Operations at the Johnson Space Center with the [NASA] Kennedy Space Center [Florida] launch team. They do all the preparation of the vehicle, and then are in the firing room and run the countdown through the T-0 liftoff time, and then they hand control over to the flight control team to do that job. The Launch Integration Manager's job was to provide some perspective for the Kennedy prelaunch operations.

The folks at Kennedy are masters at getting the vehicle ready to go, but sometimes there's a question. There's a piece part that isn't quite right, and it's going to be difficult to fix. So you have to ask yourself, "Should we fix it, or can we live for one flight or some few number of flights with this being not exactly 100% right?" So they developed this position, Launch Integration Manager, to be an operations person, an astronaut or a flight director, that would be in residence at the Kennedy Space Center, and when they had one of these difficult maintenance decisions could provide the flight perspective, and would be able to say, "Yes, this is something we can live with, it's not that important, there are other ways to work around it," or, "No, this is critically important, it's vital, and we must fix it no matter what that means to schedule or the potential to do other damage sometimes when you go into areas."

So that's the primary job of the Manager of Launch Integration. So I agreed to take that job. Ron really wanted someone there for at least three years. I agreed to take it as a one-year TDY [temporary duty], and at the end of that time we would have a review, and if I found out I really liked Florida and the Kennedy Space Center then perhaps we'd make it the more permanent assignment. I'd start out that way.

Well, that was right about Christmastime in 2002, first of the year 2003. I agreed to do that. So I went to Florida for a couple of the preflight meetings for STS-107, met people, went to the meetings, began to understand the job, and with the agreement that I would move myself down and be in place on February 1st, which was the landing day for STS-107. Of course I packed my car up and drove to Florida and got there on January 31st and moved my things into an apartment—my wife and family were staying in Houston—and then went out to the Kennedy Space Center very early the morning of February 1st to my first official day on the job to welcome the [Space Shuttle] *Columbia* crew home. Of course it didn't work out that way.

So in my mind I never really executed the Manager of Launch Integrations job, because after the *Columbia* accident it was all about finding out what happened, recovering the debris, all these sorts of things. Ron Dittemore, who was my boss, left the agency, announced he was going to leave in early April I think it was. The agency named Bill [William W.] Parsons, who I had some acquaintance with, to be the new Program Manager. He and I visited a little bit.

I was on my way home for the July 4th holiday when Bill Parsons called me on my cell phone while I was changing planes in New Orleans [Louisiana] and said, "Really like you to come be the Deputy Program Manager in Houston," which totally floored me. I hadn't even considered that I was in the running for that. I had in fact told him that I really wanted to go back to be the flight director again. Then from that time forward I was in the middle of the Return to Flight work, whereas before for those six or seven months in Florida I had been very largely involved in the reconstruction of the *Columbia* debris and helping the accident investigating team and so on and so forth.

WRIGHT: You spent two years as a deputy before you were moved into the Program Director?

HALE: Right. We spent about two and a half years getting back to flight status. We flew STS-114 in late July of 2005. I was the Deputy Program Manager at that point. We were not entirely satisfied with some of the events on that flight. But even worse than that, in August Hurricane Katrina hit the New Orleans and [NASA] Stennis Space Center [Mississippi] area. Bill Parsons had been the Stennis Center Director, was a native to that part of the world. It was very close to his heart. The agency needed somebody to coordinate recovery efforts, and they chose Bill Parsons to do that very shortly after the hurricane, within a number of just a couple of days that

the hurricane tragedy occurred. He was gone 100% of his time doing that work. They named me as Acting Program Manager at that point, and then it goes through a signoff process, and I believe it was a couple months later before I became officially the Program Manager. Then I served as Shuttle Program Manager from that point in the Fall of 2005 until this new job came about in February of 2008.

WRIGHT: As you mentioned a little bit about the roles that you've had with the program, each position had its own challenges. Can you share with us the details about the most memorable ones, and the lessons you learned dealing with those challenges?

HALE: I think one of the things that I would say about becoming Deputy Program Manager, I was particularly ill-prepared in the budget financial contracting part of the world, because a flight director is a technical person who deals with technical matters. So I learned an awful lot about technical aspects of the Shuttle and how it operates, and knew virtually nothing about the business end of the business, if you want to think about it that way.

So as I came to be Deputy Program Manager, I began to learn a tremendous amount in a very short time about contracts, awards, and award fees, and the process by which those are given out, the building of budgets, and the execution of a program within a budget. Those are all vital skills, and I had received zero training ever in any of my previous work on that. I was an engineer from engineering school. We took physics and mathematics and thermodynamics and heat transfer, and never once talked about money. In all my career as a flight controller and a flight director, we never talked about money, it was always about what is the technically optimal solution. So that was quite a shock. That was a huge learning curve for me.

Fortunately we were blessed to have really good people that could bring me along and show me what to do. Bill Parsons knew all about it. Lucy [V.] Kranz, who was our business office manager, was just superb, and many other folks as well. So I would count that as probably my biggest transition from being a flight director to program management.

Of course coming into Flight Operations was a huge challenge. I'm going backwards in time now probably 15 years before that. Coming out of college, I'd taken all these engineering classes, and you get all the equations, and you get the fundamental science and mathematics, and then you're thrown into an organization that's concerned with how you take devices which have already been built an operate them in the safest way and to the maximum extent possible to get efficiency and accomplish things. That is a totally different mindset from what they teach you in college, which is design, this is why it works, here's the theory about how it works, here's maybe some practical design, build kind of things. Operations is a subject unto itself. So I had to learn a lot about operations.

Also learned a lot about systems engineering. Mike [Michael D.] Griffin and many of our other leaders are very interested in systems engineering, which is going across disciplines in engineering science and understanding how they all fit together, which again was not a course that I ever had in college. It was something that you were required to do as a flight director. You had to understand how the radios worked, which is electrical engineering, and how the engines worked, which is thermodynamics, and how the payload bay doors opened and closed, which is mechanical. So you had to really take into account all the different aspects. How the software, computers controlled all of this and on and on. So systems engineering is something that was largely self-taught or acquired by virtue of being in the organization that had to integrate all of those things.

WRIGHT: Reflecting on those experiences, what are the best practices or the sound processes that you feel benefited you through the last 30 years?

HALE: Well, that's a tough question. I think having an open mind is really important. Knowing when you come to the table that you're probably not the expert, being able to listen to the experts, and knowing their limitations, because an expert typically is really knowledgeable in a very narrow range. So when you're trying to design a spacecraft, operate a spacecraft, accomplish something, you need to understand that the expert can give you the opinion on their very narrow scope, but how you fit all that together requires listening to a lot of people in a lot of areas. I would say that the best practice a manager can have is to get as much input from as many different sources as you possibly can, and then you have to figure out when you have to decide. Because, have you got enough information? Have you got any more time to get more information? Or has the time come that you've got to make a decision and move on?

That's an art, and I studied under several people who had that, who were wonderful practitioners of that art. Folks like Tommy [W.] Holloway and Gene [Eugene F.] Kranz, and others that I could name who were exceptional at being able to listen, take it in, and evaluate, and put the pieces of the puzzle together and make it operate. That's good training to be a manager in many areas. It's also absolutely what's required to have a safe and successful spaceflight.

WRIGHT: So much of what you're sharing with us is information that you picked up along the way working with others. If you could, how would you recommend to best train and equip the next generation of people who are going to work in the space agency?

HALE: I don't want to leave you feeling like none of the NASA training has been of value to me, because it's been extraordinarily valuable. I've had a number of classes that had to deal with technical matters as well as organizational matters, some of which were extraordinarily good, some of which were maybe not so good. But there have been some really key classes. I look back on a series of classes that I was given as a new first-line supervisor. I remember the instructor's name was Ray, and I'll remember his last name somewhere along the way. But he was an experienced civil service supervisor who had retired and then taught these classes. He was extraordinarily adept at pointing out how you deal with people, how you lead people, how you motivate people. Many of the lessons that I got in that class, which was my very first supervisory class at NASA, served me very well.

We had another set of classes called Seminar in Management that there were subtleties there on people's psychology, how you deal with people whose personality types are different than your own, that I also found extraordinarily helpful. So I don't want you to think that I just sat back and figured this out on my own. We had many good instructors. On technical subjects I had a number of good technical classes, how to do software and other things. The only classes that I missed along the way were the budget classes. That remains I think probably my weak point. But those were the ones where I just really had some very good people who coached me through.

WRIGHT: How difficult was it to take time to attend these classes and learn from these classes when you had so much to do on a day-to-day basis?

HALE: Well, it's very difficult. You have to make time for it. The interesting thing about being in Flight Operations or a flight director is your work is a little bit episodic. So you have a mission, you're preparing for that mission, you do all the preparation, you do all the training, you go execute that mission, and then after the mission's over you have some downtime before your next mission comes around. So that was always a good time to plan to take some training. I tried to take advantage of that.

One of the courses—and you'll laugh when you hear this—that I never took was MEP, which is one of the flagship programs that NASA offers for their midlevel managers. I was signed up for that class three times I think, and heard wonderful things about everybody that's been to that. Apparently you learn a lot. Three times I was signed up to take the class, and three times the mission slipped right onto the class time and so I had to cancel. So I wound up actually never taking MEP class.

WRIGHT: That stands for?

HALE: Management Effectiveness Program, I think. It's one of the key classes that virtually anybody in the agency that's in upper level management has gone through. So I missed that class.

WRIGHT: Three decades of a continual movement throughout the program—you started talking about some lessons that you've learned. Can you share those that you feel improved management performance? If you had to share with someone a lesson or more than one lesson about what you feel would help in future management performance, what would that be?

HALE: I think it's important as a manager that you explain to your people what you're doing and why you're doing it. A manager has to make decisions, little decisions, big decisions, earthshaking decisions, all kinds of decisions. That's what you're called on to do as a supervisor or a manager every day. Everything from who gets the next assignment to what the goals of the agency are. There's all sorts of things in between. I've watched many managers and have been in many management classes where they've given us examples of people who just made a decision and people didn't understand why, therefore they were not supportive sometimes, and sometimes countersupportive.

It's extraordinarily important, I think, for a manager to take the time, because it takes time to say, "We looked at all the options—or we looked at all the options that we had time to look at—to the maximum extent possible, and we chose Path A, and the reason why we chose Path A is this and this and this and this, and the reason maybe we didn't choose B or C or some other things, we're going to try A, and here is why, and we think it'll be the best way to reach our ultimate goal." If you don't take time to explain to your people, then they can't get on board. Many times choices are not clear, and it's frequently not clear to the folks that don't get to hear all the input.

So most of the working troops are not going to hear all the pros and cons and puts and takes that are involved in a decision. When you have a supervisory position you have to choose one. Then when you choose, it's important not just that you've chosen, but that you take the time to explain why and why this is the best option. It's even okay to say, "B was a pretty good option, it was really close, and we may regret not having chosen B, but we chose A, and here is

why." I think a lot of times people get in trouble because they don't take the time to explain to the folks that are going to really do the work why it is we chose that path.

WRIGHT: Talk to us about your lessons you learned with planning.

HALE: The first lesson I would tell you about planning is you've got to be flexible, and you have to have a plan that can change, because circumstances and events outside your control can come in and spoil your plan. So it is absolutely imperative to have a plan, because you have to know what you're trying to accomplish and what the milestones are along the way, because you have to monitor. You can't just throw the plan out there and hope that by next Christmas it's going to come together.

You have to have some milestones along the way to say, "Have we got the right people doing the right things? Do we need to put some more management emphasis? Do we need some more resources in an area? There's some other people ahead, and we can take some of their effort and apply it to the areas that are behind." You have to have a plan, milestones and schedule and resources, so that you can accomplish your goal, well thought out. But more important than that, you have to always be looking every day, and when something changes in the universe and your plan will no longer succeed or be the most effective way to succeed, you have to be willing to recognize that and go back and rethink your plan.

I would say in our business in particular we have those kind of events more frequently than we like to think. So you have to be ready, willing, and able to accept a change in plan and roll with those punches. Sometimes if it's a big plan and you've been working on it for a long

time, that's psychologically difficult to do. But if you keep leading down the same path when the bridge is out you're going to come to disaster. You're not going to accomplish what you want.

WRIGHT: Hopefully everyone likes to accomplish their plans and their goals within the milestones, and I think they call that efficiency. So how about program efficiency? What lessons have you learned in working with trying to put all those pieces together?

HALE: Well, I would tell you, there are a lot of management fads and they have come and gone, and you see a management fad every four or five years come through. Usually there is a kernel of goodness in any particular scheme, but you've got to be careful not to buy into it too much, because there is no panacea. If there was a panacea, we would already be doing it. I'm not a real believer that we're going to revolutionize the way that we're going to plan, organize, and manage. I think we make incremental improvements from time to time. There are some good practices, and it's good to use them. I don't know, we went through TQM [Total Quality Management], and Kaizen, Lean, Six Sigma, and you can name these things. The One-Minute Manager [by Kenneth Blanchard and Spencer Johnson] was very popular for a while. Well, the one-minute manager is good to a certain extent, but you really have to give people more than one minute of your time if you're really going to lead them to do something great.

So I don't want to make too light of these, but you take what's good and use it and recognize that it's like the grapefruit diet. You're not going to get skinny just by eating grapefruit. You got to have something across the board that will balance out. Not every scheme fits every circumstance, and probably no scheme fits your circumstance exactly. So you have to take what's good and use that and modify it.

Probably the best management technique I could give you is to have abiding respect for your people. If you don't have an abiding respect for your people deep down—and I'm not talking about how you behave or what's on the surface—deep down, if you don't have an abiding respect for your people, you might get away with some short-term very quick-result kind of a project, but if you're in for the long haul that's not going to work. So you have to learn what's good about your people. Coach them on what's bad, but always have respect for them, and always treat them as not a tool but as human beings.

I think far too often—and I've been to some management classes like this—they talk about people as tools. You treat people and their careers, well, it's just business. We need you here, we don't need you there. If you don't fit goodbye. I think if you're interested in the quarterly stockholder report return, you might get away with that for a couple of quarters, but if you're in for the long haul, you really need to respect your people and treat them like people and give them the benefit of the doubt and go the extra mile in helping them to improve. People are not tools. People are people.

WRIGHT: Every day in NASA's business, risk is an underlying factor of everything that you do. So I'd like for us to visit that topic for a little while, and staying on for just a second about the lessons. Risk assessment, are there some lessons that you can share that you learned on assessing risk?

HALE: Yes. One of the things that we are enamored with is engineers, and NASA is just full of engineers, in case you hadn't noticed, we promote engineers and we deify engineers and the ethos of NASA is engineering, and engineers love numbers. That's one of the hallmarks of an

engineer. So we like to reduce everything to a number. We like to have an equation. We like to come up with a probability in terms of risk. Probabilities, remember what Mark Twain said, "There's lies and damn lies and then there's statistics." You have to keep that in mind. We do the best we can. But the statistics are only as good as the information going into them. We put an awful lot of time and energy in the Space Shuttle Program into probabilistic risk analysis. I'm very proud of that. We did a really credible job. We put a lot of effort into it. I would tell you that I still don't believe those numbers completely. It is a tool.

We are in a very risky business. The problem that we have really created for ourselves is we sold the Space Shuttle many years ago being a routine, relatively safe means of transport to low Earth orbit. It's neither. I can't imagine what folks were thinking when they said that. Because if you think about really what's happening, we're at the cutting edge of technology still after 30 years. It's an extraordinary amount of energy and a very confined and limited envelope to be used. If any little thing goes wrong, you're going to really have some bad consequences.

So going into space, whether you're talking about on the Shuttle or an expendable rocket, or any other way known to mankind, is extraordinarily difficult and extraordinarily risky, and it's not routine. Frankly I wish it was, but I don't expect it to ever be that way in our lifetime, probably not for quite a while.

WRIGHT: Can you give us an example and share some details of a successful risk mitigation activity or management activity that you know, or you were involved with, that impacted the Shuttle Program?

HALE: Well, risk mitigation is inherent in everything that we do, because those of us that are inside the business that have really seen what this business is all about know that it's a risky business and put all of that PR [public relations] media stuff to one side. It's a risky business. The high-energy parts of the business get the most attention.

I'll give you an example of main engines. We're extraordinarily worried about the main engines. Not that they're bad engines. Quite the opposite. They're very good engines. But because of the very nature of the business and the amount of energy that's contained in that very small confined space and what goes on. So one of the risk mitigation techniques is we do a lot of ground tests. Yes, you have good design principles, and manufacturing is very strictly controlled, and all those things are very important. But the ground testing is extraordinarily important.

We have tested and retested and overtested every aspect of the engines. We find things in the ground tests. If you find it in the ground test, where no real harm done if you break a part or something, and you prevent an accident in flight, then you have done a great deal of service. So I would tell you in the propulsion world, again going back to my roots, that is probably one of the best examples of risk mitigation.

I think one of the problems where the Shuttle Program got in trouble as opposed to Apollo is they did a lot more testing in Apollo and a lot less analysis. Today we believe our computer models a little bit too much. Computer models are always an approximation of reality. There is no substitute for a well thought through and executed test program. So it costs more money almost invariably, and it takes facilities, and sometimes very specialized facilities that are in great demand. But test is 100% better than analysis. Having an analysis is better than nothing. You don't want to operate on guesswork, and sometimes you have to rely on analysis.

But testing is extraordinarily important. I think, in the Space Shuttle main engine world to take an example—it's also true in the solid rocket motor world—an extensive ground test that goes on through the operation of the vehicle has been a key element to helping us be as safe as we can be, in an extraordinarily risky part of the program.

WRIGHT: How would you suggest to the management at those levels to instill those practices that you're talking of?

HALE: I think inherently over the years we've learned good practices. Coming out of World War II in the early Cold War era and the early rocket launch business, you can think through all those newsreel movies of rockets going up in flames on the launchpad and things like that, you learn these very difficult practices. Frankly, some of the people that have come along and said, "Oh, we can build a rocket better than you can, and we'll do it with three guys in a trailer house out here," they may get away with it for a time or two. But generally they find out there's a reason why things are the way they are. Because margins are small, energy is high, environment's unforgiving, it's not like flying an airliner, it's much more difficult.

So we have learned all those lessons. I would submit we know them very well. The problem is we get pushed. There isn't anybody in this agency that if you came up to him and said, "We really want to do your mission, but you got to do it for 2% less or a month faster, can you do that?" Well, we're all can-do guys, we all want to be successful, we say, "Oh yeah, we can probably do that, let's take a run at doing that." In general we're successful, if you look at the history of NASA. In general, you're successful. So those people that have the resources tend to come back the next year and say, "Okay, can you do it for another 3% less or another month

faster?" You say, "Well, we figured out how to get lean, and we must be really smart, so we'll go figure out how to take another 3% off."

To a certain extent that's a good process. It makes you think really hard about what you're doing. But you cross a line, and I've seen it happen in this agency, and not just in the Shuttle Program. It happened in the Mars missions a few years back, and similar to Aircraft Operation, where you cross a line and you didn't even know you crossed it, and you went too far in trying to be too lean. We think because we've been lucky—we've been a victim of our past success—that we're smarter than we really are. So we think we can cut just a little more out of the system. Operate it just a little bit leaner. Then we're not so lucky.

Again, if you go back to basics, people always come back in the investigation and say, "Why, they didn't follow good engineering practice as defined by dadadadada document," which tells the lessons that we learned 40 years ago. People say, "Well why did those stupid managers do that?" Well, they did it because we wanted to try to do it faster, better, cheaper, you name it, and we went too far. Because there's no bright line. It's not an engineering problem per se. It's a human factors problem. There's not a bright line painted on the floor that says, "You can go this far and no farther." It's a gray continuum, and you never know when you've crossed that invisible boundary until it's too late. If you never have an accident, people always say, "Well, they could have done it cheaper." Well, maybe, maybe not. We go back to risk management.

One of the things that was happening—and I can speak from crystal clarity of 20/20 hindsight—in 2001 and 2002, we were pushing too hard to lean the Space Shuttle Program. We were cutting out things that were not good to cut out, and it caught up with us. In 1986 we were trying too hard to push the operational envelope and launch on a day when we shouldn't have launched. That is the nature of getting in trouble in this business, taking what anybody standing

off on the sidelines can see is not a smart thing to do and trying to push just a little bit too far, and put our hard-learned lessons off to the side.

WRIGHT: You've learned many lessons, and along the way you've picked up from those that have learned them. How best do we share these lessons? How do we get this information out so that people can learn things that you've learned?

HALE: One of the things that I had the luxury of doing when I first came to NASA, as I think I told you earlier, is we had about three years from the time that I came to work before the first Shuttle flight. We had a number of old Apollo guys—I say old, they seemed old to me when I was 20-something, they probably weren't that old—but they had lived through Apollo and Gemini and Skylab and those early programs, and they'd seen the Apollo on fire, and they'd been through Apollo 13, and all these other things. There's an awful lot of learning that you can do through the oral history. Well, you read the book or you saw the movie, let's tell you what really happened, because we were there.

That kind of folk knowledge culture that comes from an ongoing organization where you have people that acquired wisdom the hard way and are willing to pass it on to the younger folks who are willing to listen is an extraordinarily important way that we pass on knowledge. Unfortunately, the best teaching sometimes happens one on one. Not the big video conference that goes across thousands of people. It's sometimes just really one on one. It's hard to do, it's very expensive. I was extraordinarily lucky to have those three years.

WRIGHT: Just in case you were one of those older guys now and you were heading up this class for those that are willing to listen, what lessons would you share with them?

HALE: I actually thought about this a lot, because when I was a Shuttle Program Manager I was trying to take my senior management team, maybe just a little bit younger than I am, but specialized in certain ways, and give them a broader view. So we would always have the history lesson. We would have somebody talk about some hard lesson they'd learned from the past on a periodic basis. We'd have the book that we would read this month together and talk about and do those sorts of things. The movie sometimes. There's a few good ones out there that illustrate principles.

I think it's incumbent on every leader, every senior manager, every senior person really, to take the time out and say, "Okay, we can stay busy 100% of the time, our job has got so many urgent deadlines in it that it will keep us booked up 100% of the time, and we'll never take time off to talk about why we do things or what happened in the past or the lessons we've learned, because you can stay busy 24/7 doing just what we need to do." But I think a wise manager will say, "Okay, on this day we're going to put our tools down and we're going to talk about some important lesson, maybe a couple of important lessons, and take time out and really study on why it is we're doing the things the way we do them, and how maybe we might better do things." I think that's an important concept. You can draw people in by having that discussion. But it starts I think with the history lesson, at least from my perspective.

WRIGHT: What's the hardest lesson you think you learned?

HALE: That we're not always going to be successful. We had—there's a professor, [Charles] Perrow, who wrote the book on normal accidents [Normal Accidents: Living with High-Risk Technologies]—come and talk to us after the *Columbia* accident. We all hated him. Hated his book, hated his class, because his bottom line was that there are going to be some accidents that just sneak through no matter how hard you try.

Now we are all scientific positivists. We all like to believe that we're smart enough and hardworking enough to prevent the next accident. Well, guess what? We're not really. If we get cocky, then we're really a long way from that. So I think the hardest lesson to know is that when you're on the frontier, you're going to have some bad days. I wish it wasn't so. I wish life wasn't like that. There's some times you talk to your kids and you say, "I wish life were fair." Well, life is not fair. We're not always going to be successful. I think that tempers thinking a lot.

We learned that in January of 1986, we probably learned that back in January of 1967, and we certainly learned that in February of 2003. We're not always going to be successful. I had the opportunity to go out and talk to my friends out at the Jet Propulsion Laboratory [Pasadena, California]. They had a really bad year in 2000. So they know that lesson. It's not just in the human spaceflight part of the business. There are other examples. Things don't always go the way you planned. That's a really tough lesson.

WRIGHT: But there had to be something in this last 30 years that kept you going.

HALE: Yes, it's motivation. You have to go right to the motivation, because it is a tough business, and people say, "Well, I can't stand this prospect, and so therefore I shouldn't be in this

business," and some people have left, and I don't disrespect them for it. But you have to truly believe that what we're doing is important. It really goes to motivation.

People at NASA and most of the contract workers that we also have in addition to the government workers are not motivated by money, they're not motivated by power, they're not necessarily motivated by fame. They are motivated because what we're doing is important and they know it's important, and it is a heritage, a tradition that we have gained from the American experience. We are pressing on the frontier, and the nation and the world will be better for what we're doing. It is larger than any one of us. It's a huge goal. I think people in other industries—and I think a lot about NGOs [non-governmental organizations] that go out and help people do different things—have some of that same. What you're about is more important than one individual, and you can lose yourself in the goal. Certainly that kind of motivation is very important to work in this business, because it's a tough business. You don't get rewards in some of the traditional ways.

WRIGHT: So what advice would you share with someone who wants to join the program?

HALE: Come on in. This is the most exciting, the most fun, the most challenging career I can imagine. But you're not going to win the World Series every year either. You got to take the good with the bad, and you have to work your way up. Nobody comes in and is successful every time, there wouldn't be any challenge in that. If you want to play the piano like a great concert pianist, you've got to practice. This takes practice too, but it's very rewarding when you accomplish things.

We have a score of solid, tangible accomplishments, and at the end of the day you don't say, "Well, I just made a lot of money," or "had a nice car." You can say, "I did something for mankind," and that's a huge motivator.

There's a story I heard last week in a different location about a fellow who was out here in Houston mowing the grass, he was on the ground crew for Johnson Space Center, and it was one of those August days where it's about 100 degrees and about 100% humidity, and really hard work taking care of the grounds here, and they came up to the guy and they said, "Wow, you got to think about a different line of work, surely you could make a living better somewhere," and he said, "What, and give up the space business?" People get excited about what we do, because it's more than just a paycheck.

WRIGHT: Are there any other thoughts that you have on the topics that we've talked about today?

HALE: We talked an awful lot about risk, and we talked an awful lot about the downside. But if there's one thing that I would say more about, it's the reward. There's nothing as rewarding as doing something that you can point to with pride and say, "This is a great accomplishment." Just take the construction of the International Space Station [ISS]. That is the greatest engineering accomplishment of our time. To be a part of that and have helped that come to fruition—and I expect great things from those laboratories that we added to the International Space Station. As we get the people up there and the equipment and the racks to do the research work, I expect great things.

People will say, I think, in ten years, "Wow, that was a really great investment." Remember the Hubble Space Telescope. When we first launched it, what did they say? "Hubble

trouble. It doesn't see right." Well, we had to go up and fiddle with it and put some new optics in. Now what they say is it may be the single most valuable scientific instrument of all time, the Hubble Space Telescope. Wow, we did that. That's worth a lot.

WRIGHT: It's interesting that you said, when we first started, how you came to work or finished with Purdue at the same time that there was such a low time. But yet when you started you worked with the Hubble, flight director with they first docked to ISS shuttle, Shuttle-Mir [Program, Phase 1 of ISS], and now you work with international partners. So much has changed in really a short amount of time.

HALE: You look back and say I was extraordinarily fortunate to be in the right place at the right time, to have such a wonderful opportunity, so many great people to work with that worked so hard and came with such a great breadth of knowledge. It's just an amazing time. I'm not ready to quit. This it not my valedictory address. I'm not ready to quit. This is a wonderful business, and I wouldn't have traded it for anything.

WRIGHT: Was there a decision that you made along the way that maybe you regretted in a way?

HALE: Oh well, yes. About a million of them. But it's hard to pinpoint any one. But yes, there certainly have been lots of decisions that if I had time to do them differently or wiser or whatever you want to say I would have done differently. I'm far from infallible, and anybody that thinks they're infallible is dangerous.

WRIGHT: Was there a time that you were part of a decision-making process—

HALE: Well, I've got to tell you the one that is the most depressing to contemplate was the fact that I sat on the Mission Management Team for STS-107 in January of 2003 and was part and parcel of the chorus that said, "Yeah we're okay, we don't have any problems," and could have been smarter, talked to more people, taken more time. You fill in the blank, could have had the opportunity to stand up and say, "Now wait a minute, something's wrong here and we need to do something about it." If I had a big regret that would be the biggest, because clearly in retrospect we were going the wrong path and we had a bad result. We had the opportunity to really save the day, we really did, and we just didn't do it, just were blind to it. So yes, I've been part of some really bad decisions.

WRIGHT: What about the other side, being responsible for a decision that moved something forward that might not have gone there?

HALE: We did some very exciting things in the early days of Shuttle flight with scientific experiments, with some of the payload operations. I was involved in a very exciting mission where we used an inflatable device to see if we could make antennas just from an inflatable balloon, oddly shaped balloon, standpoint. Inflatable antenna experiment. We had to learn how to do that, observe what was going on, and stay out of the way and be safe about it. That was an extraordinary flight that I was involved in. As you mentioned, I was the lead flight director on the first flight to dock at the International Space Station, and we had to invent the procedures and

the protocols and the how to do th at. Extraordinarily exciting stu ff. Had to learn how to work with our colleagues overseas. Extraordinary.

Now if you think about world events, the fact that we took our Cold War adversaries and have built a partnersh ip, strong partnersh ip with them , that allows us to do this engineering marvel called the Intern ational Space Station, an d then throw in a whole bunch of other nations just to make it more interesting, it's not just an accomplishment in the engineering sphere, it's an accomplishment in international relations and working between cultures. It's extraordinary. The opportunity to be a part of that and help make some of those decisions has really been exciting.

WRIGHT: Can you give us an exam ple how the process has changed from when you first started working with the Russians, of course, with Shu ttle-Mir, a nd then it moved into inte rnational partners with Space Station.

HALE: I think a lot of the distrust has gone away. The thing that we have learned is that the folks working in the Russian spa ce business, like the f olks working in the Jap anese space business an d the F rench, Germ an, British spac e busine ss, Ita lian, we all think alike at hear t. When you get past the "do we like this kind of food" and "what language do we spea k," but you get down to what are we trying to accomplish, we are more alike than we are different. We have common goals, we can be excited about the sam e things. You had to get past the cultural differences to find that out. We have extraordinary partnerships, extraordinary partnerships.

I only dabbled in that five percent. You got to talk to the people th at really se t up the International Space Station working relationsh ips and did all that work. Th ey did the real heavy lifting in that regard. B ut even being involved in the little part that I was involved in m akes me

extraordinarily happy. People who are workin g, collaborating with yo u on a great and noble accomplishment, are unlikely to go to war with you or to engage in cutth roat econom ic competition with you. They are more likely to collaborate in other areas. I think that's one of the extraordinary accomplishments of the whole space program in the last 15, 20 years.

WRIGHT: Share with us how you' re taking all of your experience a nd your lessons learned and your sound processes and practices and moving them into your latest position.

HALE: This is a pos ition that th ey've asked me to help the agency bu ild som e more s trategic partnerships with other federal agencies, with s ome interna tional organizations, certainly with commercial and academ ic folks. So this pers pective, I think, is im portant to talk about collaboration, because that's really how we've gotten as far as we' ve gotten. How to work wit h people from diverse cultural backgrounds. Som etimes I think the Russi an space workers are more akin to us than so me of the academ ic folks that speak our sam e language, b ecause we're coming from a different kind of a culture, and you ha ve to learn to resp ect that and get past that and find the common ground.

So I'm going to try to use som e of the lessons that w e've learned to build these partnerships, because we actually g et a lo t more accomplished through partnerships than when we try to go it alone. We actually bring som e pe rspectives to the table that perh aps we are culturally blind to. I don' t mean American, I mean maybe engineering cu lturally blind to. You get some other perspectives, it can help you avoid problems and be more successful. So I thin k those are some of the important lessons that I'm bringing to my new job.

WRIGHT: Well, we look forward to hearing how well you do with those.

HALE: Thank you.

WRIGHT: Nothing else to add, we'll close for today.

HALE: Okay. If you think of anything else, you're welcome to come back.

[End of interview]